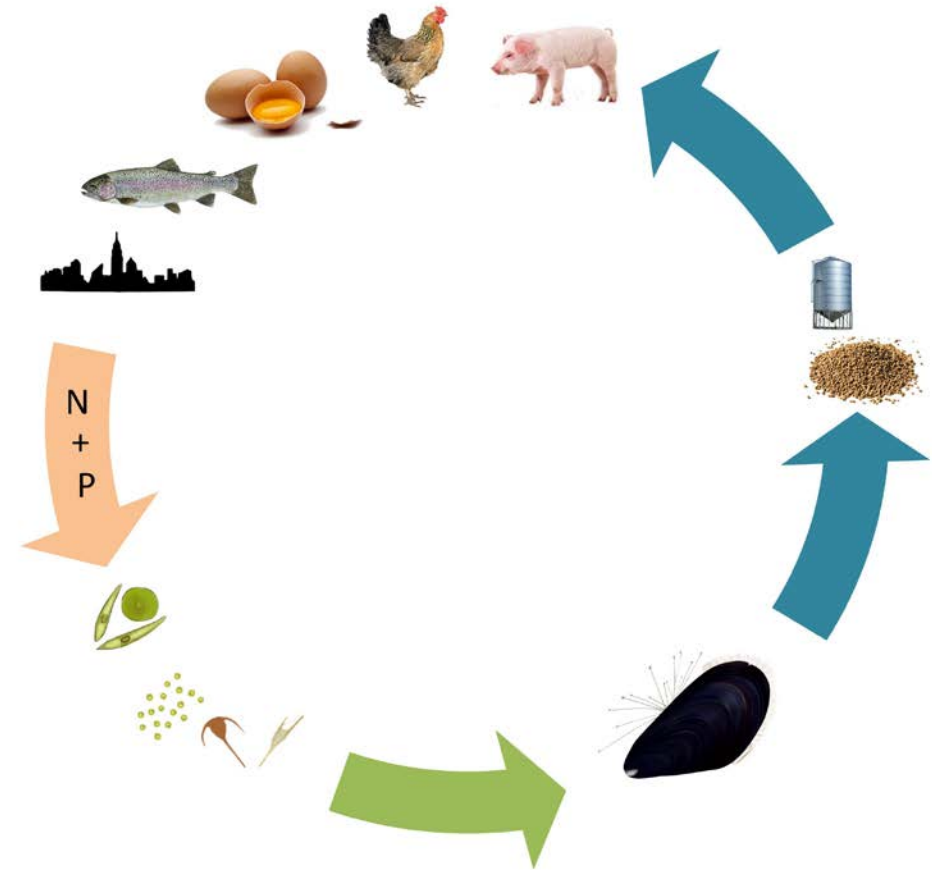


# Status, challenges and opportunities in the production of mussels and mussel protein in Denmark

**Jens Kjerulf Petersen**

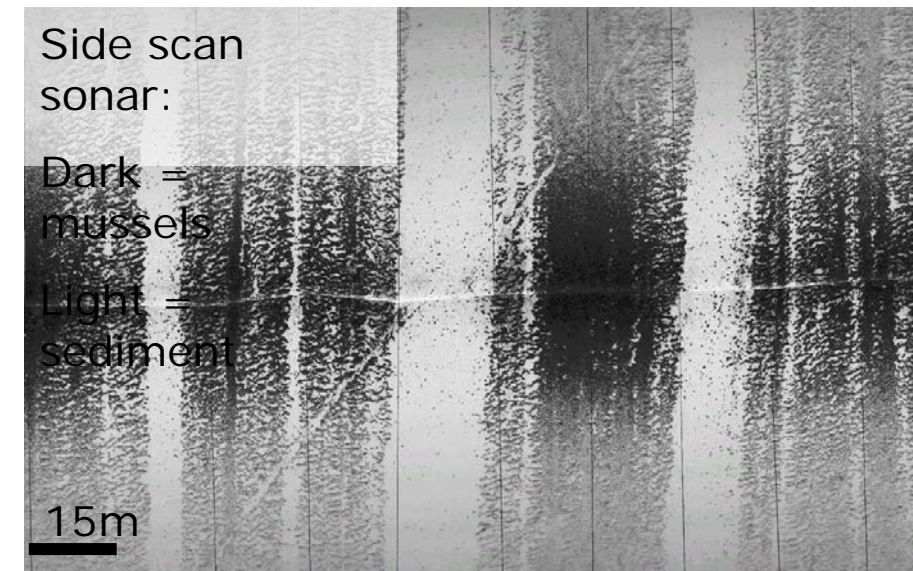
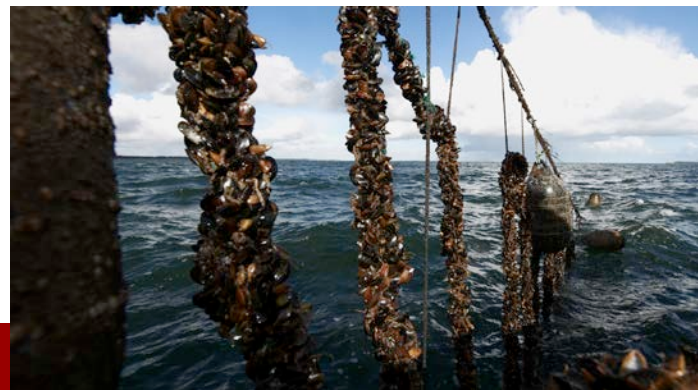
# Mussel production

- Circular – nutrients lost from land are captured as animal protein and returned to land
- High food conversion efficiency (as poikilothermic)
- No feed production for animal protein production is required



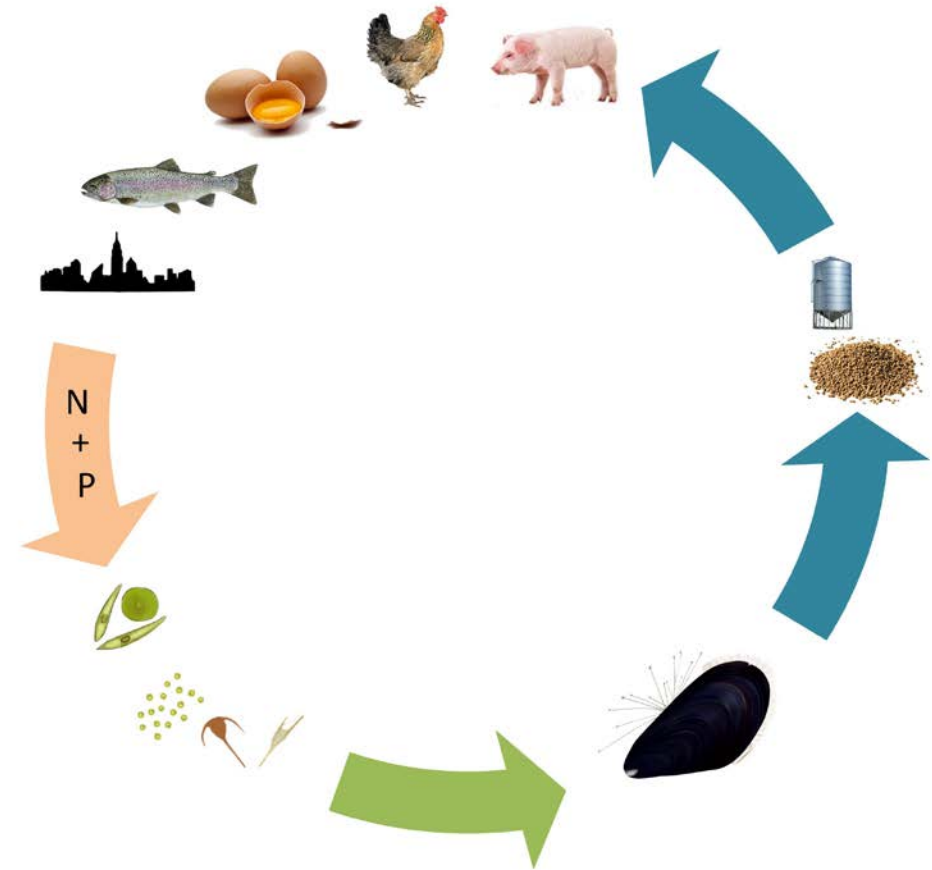
# Mussel production in Denmark

- Fisheries on wild stocks: 30-50,000 t yr<sup>-1</sup>
- On-bottom culture: 1-5,000 t yr<sup>-1</sup>
- Off-bottom culture: 3-4,000 t yr<sup>-1</sup>



# Mussel off-bottom culture

- Circular – nutrients lost from land are captured as animal protein and returned to land
- High food conversion efficiency (as poikilothermic)
- No feed production for animal protein production is required
- Can be produced in 3D leading to increased area efficiency



# Mussel off-bottom culture for human consumption



May - June



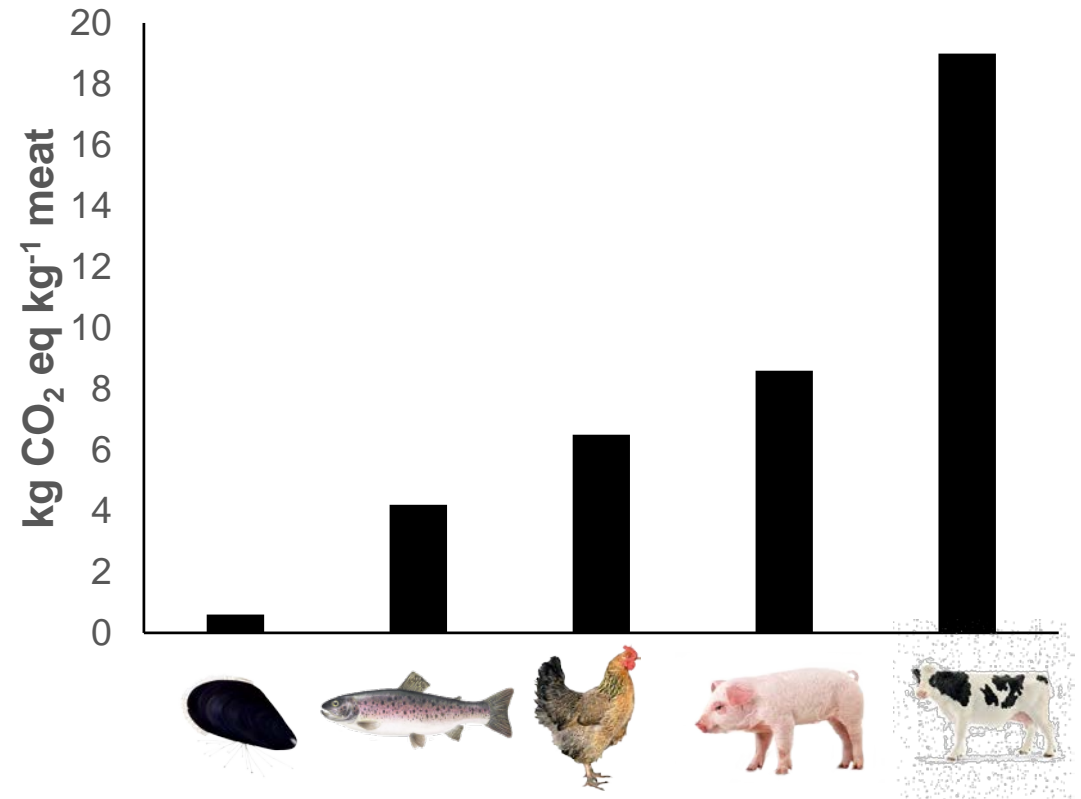
April - October

**.... and should end like this**



.... not least because

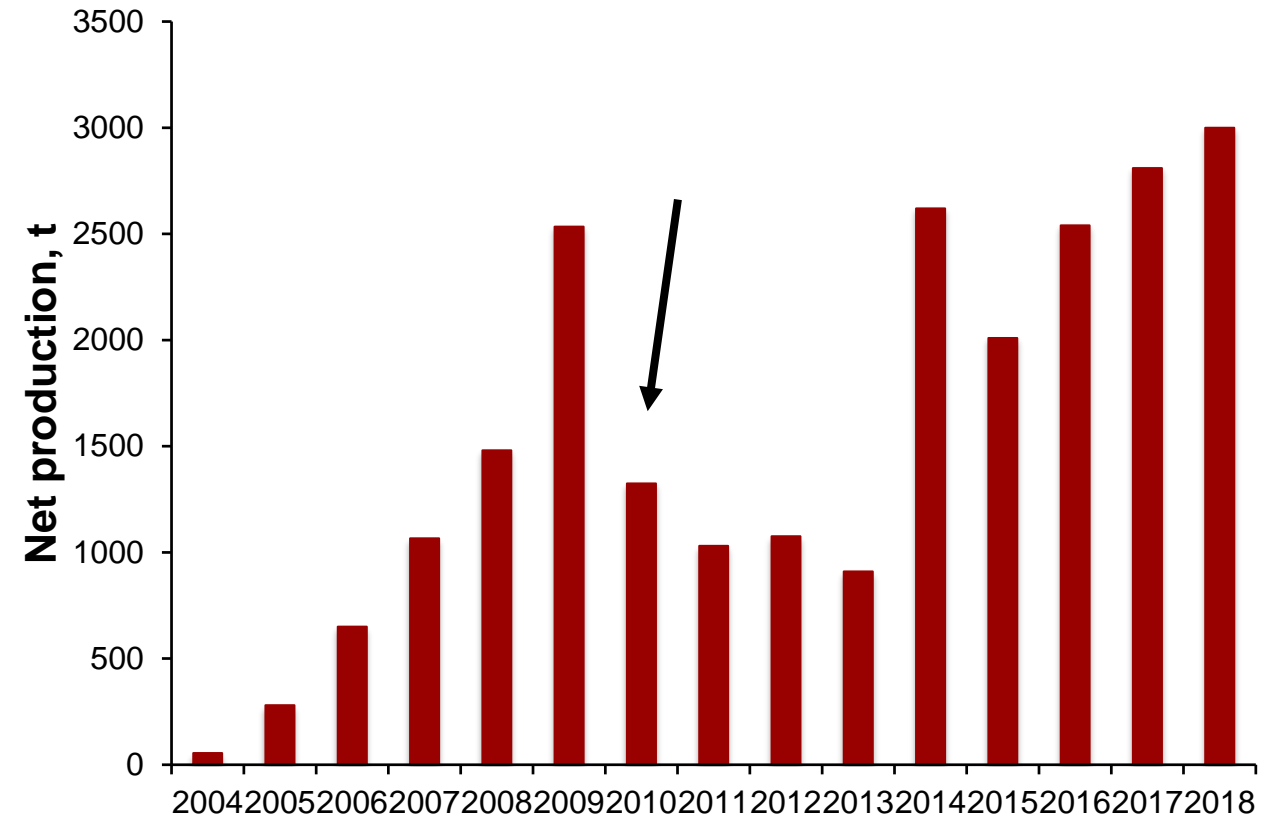
Macro nutrients	Content /100 gr
Energy	474 kJ
Protein	17,8 gr
Carbohydrates	4,1 gr
Fat	2,8 gr
Ash	1,6 gr
Dry matter	26,3 gr
Water	73,7 gr



# Mussel off-bottom culture in Denmark for human consumption

- Nutrient rich waters
- High hygienic standard
- Sheltered coastal waters
- Easy access to a license

prototype of new food (and feed)



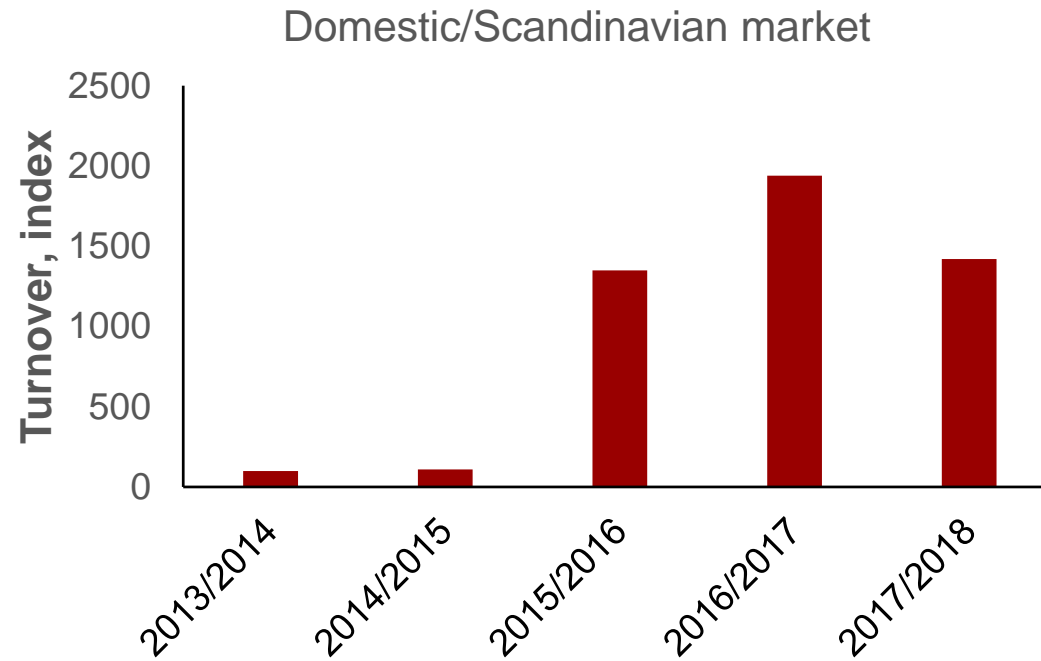
## Barriers to increased production

- Very low shellfish consumption in Denmark (and most of NE Europe)
- 80-90% exported un-processed to Europe (mainly Holland)
- High degree of seasonality
- A processing industry originating from and dedicated to fished mussels
- Few producers in a "new" business on a very competitive market (food products)

# Opportunities

- Technological development can prolong the season
  - Spat collector treatment to avoid fouling
  - Double socking
- Story telling and simple measures can increase domestic market share
  - Mussel long-line farming can be **certified organic**
  - Influence "influencers" – chefs, masterclasses, canteen suppliers, gastro journalist, food trucks at festivals, etc
  - Create new entries to super market chains – not the traditional

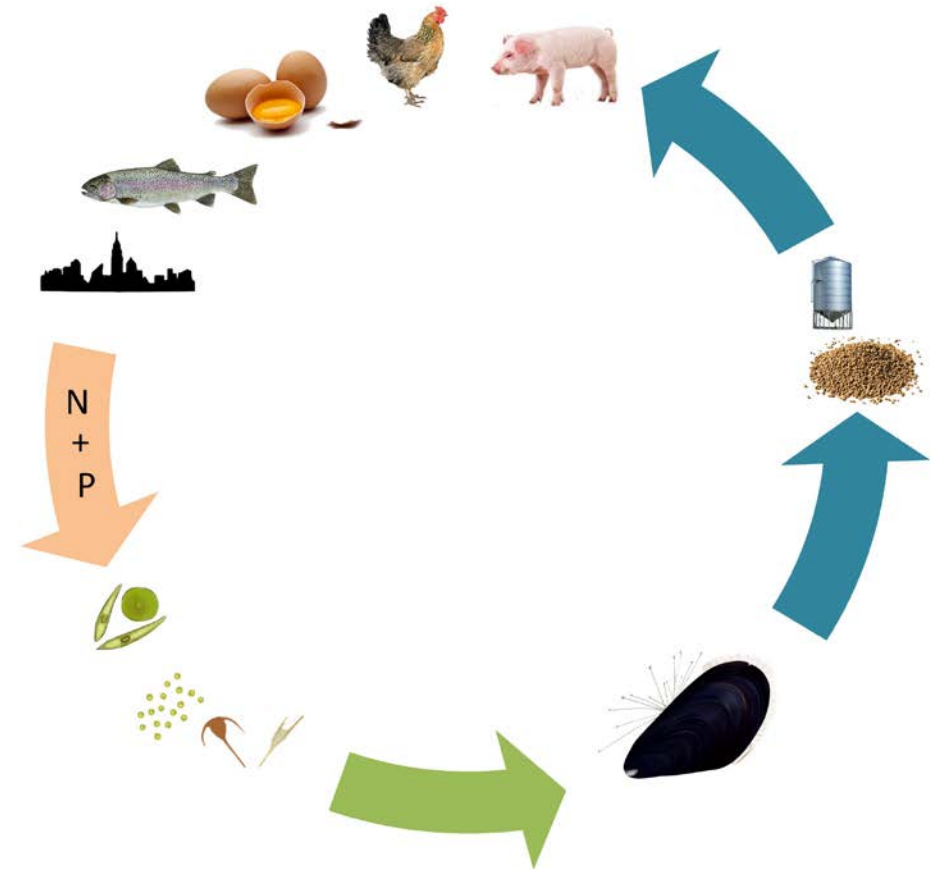
# Some results



<http://www.skaldyrcenter.aqua.dtu.dk/forskning/fomus#fomus-dk>

# Mussel off-bottom culture for mitigation

- Circular – nutrients lost from land are captured as animal protein and returned to land
- High food conversion efficiency (as poikilothermic)
- No feed production for animal protein production is required
- Can be produced in 3D leading to increased area efficiency
- New production is a requirement



# Nutrient removal

Time	Meat		Shells		Byssus		Total	
	N	P	N	P	N	P	N	P
Winter	7	0.5	2.6	0.01	1.3	0.01	11	0.5
Spring	9	0.7	4	0.02	3	0.02	16	0.7

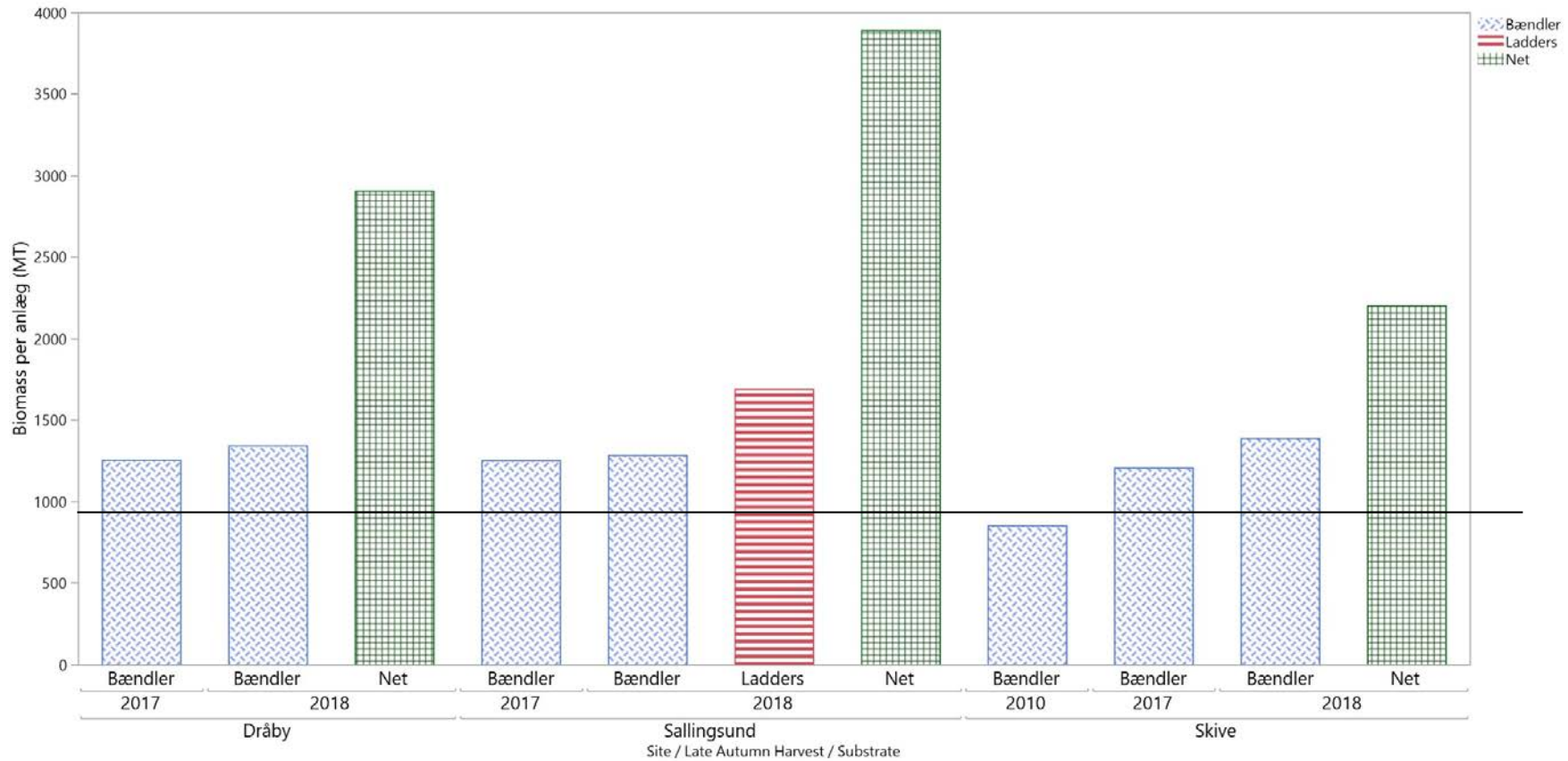
In a 18 ha standard long-line unit

- Corresponds to an area efficiency of 0.6-0.9 t N ha<sup>-1</sup>
- In comparison: Wetlands and protection zones are assumed to have an area efficiency of 0.2 t N ha<sup>-1</sup>

# Mussel off-bottom culture for mitigation



# Technological improvements



# Nutrient removal

Time	Meat		Shells		Byssus		Total	
	N	P	N	P	N	P	N	P
Winter	7	0.5	2.6	0.01	1.3	0.01	11	0.5
Spring	9	0.7	4	0.02	3	0.02	16	0.7
Winter, LL							18.0	1.3
Winter, nets							36.8	2.5
Winter, ladder							22.6	1.5

In a 18 ha standard long-line unit

- Corresponds to an area efficiency of 1-2 t N ha<sup>-1</sup>

# Cost efficiency of nutrient removal

	€ kg <sup>-1</sup> N
Mussel farming	9-15
(Incl. mussel clearance)	1.5-2
Land based abatement	3.5-27

Sale or waste disposal of the harvested mussels is not included in the costs

Goods and services: important, but estimated

Land based tools:  
Most of the available tools in the high end of costs

Mussel farming creates jobs, often situated in rural areas

# Product



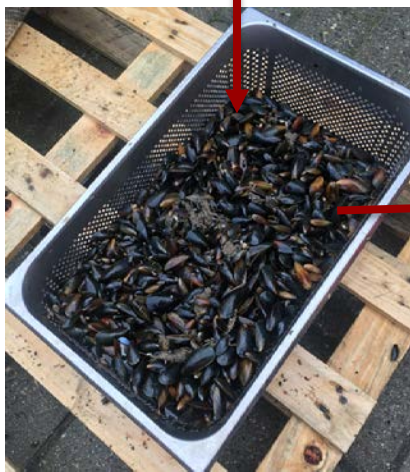
# Processing for mussel meal as feed ingredient



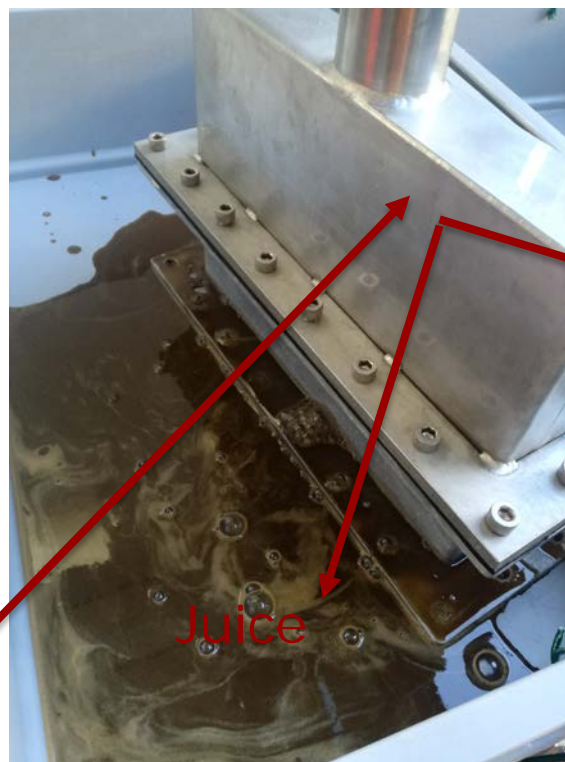
# Alternative processing



Rinsing



Mincing

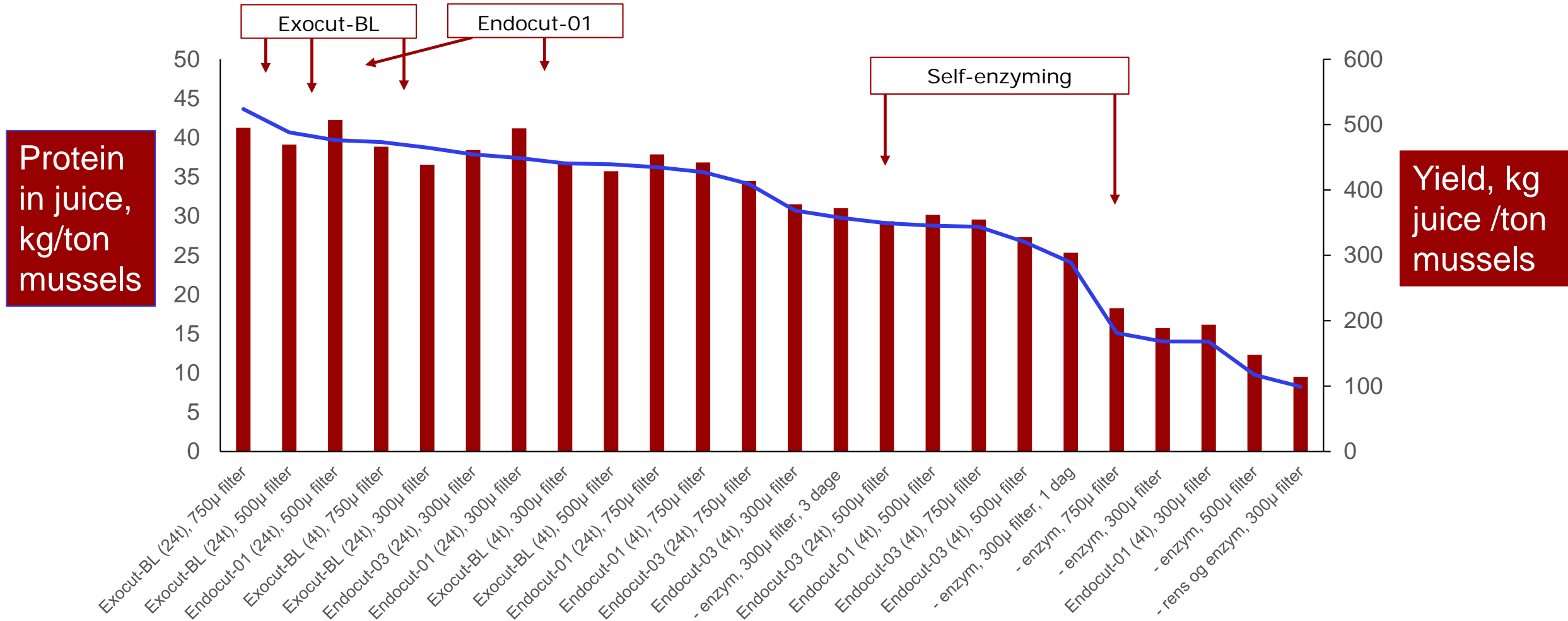


Juice



Filter residue

# Some results



# ... for what?



See more on:

<http://www.bonus-optimus.eu>

<http://www.mumipro.dk>

## Perspectives

- Mussel production can become a new sustainable source of valuable animal protein for (organic) husbandry
- Predicted potential in a report to the Bioeconomy panel is 100,000 t of mussels for mitigation and 10.000 for consumption can be produced off-bottom in Denmark
- Further development of processing technology is required because the present methods will not result in a product competitive with e.g. fish meal
- Payment schemes for ecosystem services provided by mussel off-bottom production can be an incentive to develop production of a new sustainable protein source
- CAP is a barrier to use mussel off-bottom production as a mitigation measure

# Challenges



## Summary

- Mussels (and other shellfish) are a (new) source of valuable proteins for food and feed
- As with other (new) sources, production and processing technology have to be improved
- Consumer acceptance can be achieved by story telling on "soft values"
- Payment for ecosystem services can become a driver (equal to the wind energy development)



Thank you